Thin-Film Broadband Large Area Imaging System

NASA

Completed Technology Project (2015 - 2016)

Project Introduction

Fabrication of telescopes, even of relatively modest size requires uniquely complex technology and resources available only to large and specialized institutions. This monopoly is about to be challenged with dramatic cost reduction due to the advent of waveplate lenses and mirrors pioneered by BEAM Co. The objective of the proposed study is to develop concepts for applying diffractive waveplate technology to NASA observation and imaging missions including exoplanet detection. This technology employs "geometric phase" in focusing electromagnetic radiation. The system concept to be developed will comprise a thin-film, nearly weightless broadband diffractive waveplate lens that provides angular resolution and light collection capabilities needed for such missions while allowing aperture sizes to be expanded to levels prohibited by technology or cost considerations for any other currently known concept. Chromatic aberration correction techniques previously developed by us for laser communication applications may be extended to broadband imaging with submicroradian angular resolution. The proposed concept will lead to a new and promising design approach for very large aperture space telescopes making them inexpensively available for accomplishing future NASA missions.

Anticipated Benefits

Sending telescopes to other planets - small, lightweight, and less expensive, is one of the major opportunities provided by the proposed research. Relatively inexpensive larger area telescopes would allow more frequent launches, for example, for observing the Earth. A number of missions covering a range of scales would greatly benefit from the availability of bigger and/or less expensive telescopes, e.g., ATLAST; (http://www.stsci.edu/atlast), the Exoplanet imager Exo-C, at 1.4 m (http://exep.jpl.nasa.gov/stdt/exoc/), and even Cubesats. Exoplanet detection missions in particular would be enabled by higher angular resolution than is feasible with current space telescope technology.



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Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations	
and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Project Website:	3
Technology Areas	3
Target Destination	3



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Primary U.S. Work Locations and Key Partners

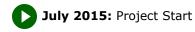


Organizations Performing Work	Role	Туре	Location
BeamCo	Lead Organization	Industry Women-Owned Small Business (WOSB)	
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations

Florida

Project Transitions



Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

BeamCo

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

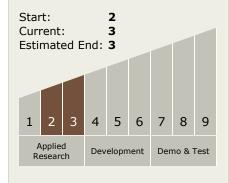
Program Manager:

Eric A Eberly

Principal Investigator:

Nelson Tabirian

Technology Maturity (TRL)





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June 2016: Closed out

Closeout Summary: Our Phase I program has addressed the possibility of appl ying thin-film diffractive waveplate technology to large aperture space-based tel escopes for such applications as exoplanet imaging and spectral analysis. The m ajor benefit that may be achievable with this technology is to make very large a perture, diffraction limited, space-based imaging possible at a small fraction of t he cost that would be incurred with alternative methods using conventional optic s including a reflective primary mirror. We have developed a point optical design that is predicted to achieve diffraction-limited imaging in the visible wavelength band over a bandwidth of \xb18% of the center wavelength. The geometrical ph ase modulation introduced by waveplate lenses is wavelength independent - res ulting in the broadband nature of these new generation components and feasibili ty for having near 100% diffractive efficiency over very broad range of waveleng ths. Since, however, the diffraction angle depends on wavelength, the bandwidt h of a diffraction-limited astronomical telescope with a flat, transmissive primary element may be limited by chromatic aberration. Finding solutions to the proble m of chromatic aberrations was an important task during Phase I of our progra m. Luckily, unlike conventional mirrors and lenses, our novel optical components provide a myriad of opportunities to deal with the problem - we found an opport unity of increasing the diffraction limited bandwidth by near 16,000 times! While alternative diffractive optical techniques for large-aperture space-based imagin g, there has been only a small effort devoted to DW lenses and mirrors for this a pplication. In view of the critical potential advantages of this technology over th e alternatives, we believe that these techniques merit further investigation for s uch applications.

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Areas

Primary:

- TX08 Sensors and Instruments
 - □ TX08.2 Observatories
 - ☐ TX08.2.3 Distributed Aperture

Target Destination

Others Inside the Solar System

